Change in stress with seismic cycles in coherent and mélange units in the Cretaceous Shimanto Belt, SW Japan

*Makoto Hashiguchi[1], Yoshitaka Hashimoto[1]

1. Kochi University

Stress state in a subduction unit can be exchanged between reverse and normal fault regimes with earthquake cycles. A similar change in paleostresses has been also obtained in some exhumed accretionary complexes. However, the previous studies in exhumed accretionary complexes cover only mé lange units along the coastline.In this study, we spatially examined a regional paleostress change in a coherent unit as well as an adjacent mélange unit in a mountain area.

The study area is located in the Cretaceous northern Shimanto Belt. A coherent unit distributs in the north and a mélange unit is located at the south adjacently. Strike and dip of the bedding and foliations of mé lange are NE-SW and steeply to the north, respectively. Many micro-faults are observed in both areas with nicely visible slicken side and slicken steps. We have measured slip data from the micro-fault for the inversion analysis of paleostress. Among six stresses estimated, our stresses could be reasonable for each unit because many unique faults are found. In the coherent unit, the stress states include two reverse fault regimes, one strike-slip fault regime and one normal fault regime. In mélange unit, one reverse fault regime, one strike-slip fault regime and two normal fault regime were identified. The orientations of the principal stresses are mostly consistent in NW-SE, NE-SW and almost vertical directions. The results suggest that the stress exchange is commonly observed in both coherent and mélange units.

In order to constrain stress magnitude, stress polygon was employed. Effective vertical stress (Sv’) was assumed as 140 MPa corresponding to the depth about 5.5 km which came from the maximum paleo-temperature (165 ˚C) of vitrinite reflectance. The stress magnitude for the reverse fault regimes is larger than that for the normal fault regime normally in both areas. In addition, the difference of the maximum shear stress (stress drop) was examined. The maximum shear stresses for each stress regime were estimated by the half of the differential stress (SHmax-Shmin). The stress drops between reverse and normal stresses ranges 1.8-63 MPa in the coherent unit. The stress drops are consistent with the range of 0.01-100 MPa in trench type earthquakes. Therefore, it is possible for our results to be related to earthquake cycles at least for the coherent unit.

In the mélange unit, because reverse fault regime did not fit the stress polygon with 140 MPa of Sv’, the stress drop could not be estimated.

Fluid inclusion analysis was conducted in mélange unit to obtain pressure-temperature (P-T) conditions of mélange unit. Homogenization temperatures of methane inclusions give methane density and these of water-rich inclusions show the trap temperature because water was saturated with methane at the time. The trap pressure can be obtained from the combination between methane density and the trap temperature. Two samples were measured so far. One is a normal fault and the other is a reverse fault. The P-T conditions for the normal fault range 190–237˚C and 174.2–196.9 MPa, respectively. These for the reverse fault are 167–211˚C and 79.5–91.5 MPa, respectively. The pressure for the normal fault shows twice higher than that for the reverse fault. The P-T conditions are not consistent each other, suggesting that the timing of the micro-fault development in the units are different.

In conclusion, the exchange of stress accompanying earthquake cycles could occur both in the coherent and mélange units. The interpretation that the exchange of stress observed both in mélange and coherent units implies that the exchange in stress state could be recorded after mélange unit was located adjacent to coherent unit. It suggests that the micro-faults were activated within an accretionary wedge. However, the P-T condition of fluid in the both faults show inconsistent. To understand the effects of fluid, further fluid inclusion analyses in the mineral veins will be required.

Keywords: micro-faults analysis, fulid inclusion, accretionary complex

